What is TCP/IP:

- The terms TCP and IP itself can be identified as an abbreviation of Transmission Control Protocol and Internet Protocol.
- Both protocol are combined together to provide network communication standard within the wireless and wired network environment.

This chapter will focus on the following technology:

- TCP/IP
- Wireless network
- Wireless Communication

Introduction:

- Wireless networks are becoming more widely deployed and more often used to access services in the Internet.
- Internet technology has been successful in providing services to users in fixed networks.
- In wireless networks, on the other hand, the performance of the Internet protocols has been reported to be much lower than in fixed networks.
- The main reason for the performance degradation is that the Transmission Control Protocol (TCP) works less efficiently in wireless networks.
- This problem is important, since TCP is used by many popular Internet applications, such as e-mail, web browsing, and remote login.
- Wireless LANs can be found on college campuses, in office buildings, and in many public areas.

In this section, we concentrate on two wireless technologies for LANs: IEEE 802.11 wireless LANs, sometimes called wireless Ethernet, and Bluetooth, a technology for small wireless LANs.
TCP/IP over WIRELESS NETWORKS

Overview:

TCP:
- TCP is a connection-oriented transport protocol which provides a reliable byte stream to the application layer.
- Application data submitted to TCP is divided into protocol data units (PDUs) called segments, before transmission. Reliability is achieved.
- The performance of TCP may be enhanced by the use of optional features.
- Some of the commonly used options which are relevant for TCP in wireless networks are selective acknowledgments (SACK), timestamps and window scaling.

TCP: Windows Scaling
- With the window scale option, a larger window can be used, since the transmission is limited by the advertised receiver window.
- This means that the transmission is limited by the advertised receiver window, although the network can transport more data.
- The window scale option can be used in order to utilize the network capacity between the sender and the receiver more efficiently.
- The bandwidth-delay product (a measure of the capacity) may be larger than the maximum value of the header field for the advertised receiver window (16 bits).
- This means that the transmission is limited by the advertised receiver window, although the network can transport more data.
- With the window scale option, a larger window can be used, since it is possible to advertise a receiver window of 32 bits.

TCP: Timestamps
- The timestamps option provides an additional means to identify continuous blocks of received bytes in the same acknowledgment.
- A 12 byte timestamp is added to outgoing segments and the receiver adds the same timestamp to the acknowledgments going back to the sender.
- If the timestamps option is enabled, then the sender can sample the round trip time with a higher frequency, which gives a more accurate round trip time estimation.

TCP: Selective Acknowledgements
- The selective acknowledgment options (SACK) improves TCP performance, if multiple segments are lost in the same window.
- With SACK enabled, a receiver can acknowledge up to three non-continuous blocks of received bytes in the same acknowledgment.
- The sender then knows which segments are missing and can retransmit only those.

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Wireless Network:
- A cellular telephony network, for example, is connected to a wire line network by an inter-working unit, and a wireless local area network (WLAN) is interconnected with an access point (also called base station).
- Some type of intermediate node is required to connect a wireless network with a wire line network.
- Wireless links are not as robust as wire line links, since the radio quality may vary considerably over time, the bandwidth is usually lower, and transmission errors occur more frequently.
- Signal strength weakens with the distance between the mobile station and the base station, and radio waves bounce off objects, giving rise to interference and multi-path effects.
TCP/IP over WIRELESS NETWORKS

**Overview**

- WLANs are standardized both by IEEE and by ETSI.
- The standards cover the physical layer and the medium access control (MAC) protocol used in the lower part of the data link layer.
- On top of the MAC protocol, a logical link control (LLC) protocol, such as IEEE 802.2, is typically used.
- The data rates are much higher than in wireless wide area networks. In comparison to WWANs, mobility is more or less limited, depending on the technology used, e.g. infrared WLANs hardly support mobility at all.
- Today, WLANs with data rates up to 1Gbps are commercially available.
- The cost for this higher data rate is that the terminals must be close to the access point, e.g. 50-100 meters.

**Overview**

- As IEEE 802.11 is the dominant standard for WLANs, we have chosen to describe the IEEE 802.11 standard in some more detail below.

**Overview**

- In the IEEE 802.11 standard, the algorithm used for medium access control is carrier sense multiple access with collision detection (CSMA/CD).
- Handover is initiated by the mobile station. It takes between 60 and 400ms for a handover to complete, depending on the network interface card.
- In the IEEE 802.11 standard, the algorithm used for medium access control is carrier sense multiple access with collision avoidance (CSMA/CA). CSMA/CA is similar to the access control used in wire line LANs, CSMA with collision detection (CSMA/CD).

**Overview**

- The first generation of cellular telephony networks were based on analog technology for the radio interface.
- In comparison to the second generation (2G) of cellular telephony networks, the first generation networks are less suitable for data traffic, since lower bandwidth, poorer radio quality, and less security are provided.
- The 2G systems are digital and based on either time division multiple access (TDMA) or code division multiple access (CDMA).
- In TDMA networks, a mobile station can only listen to one base station at a time.
- As a result, there is a short loss of connectivity during handover, as a mobile station moves from one cell to another. A handover which results in a short interruption is called a soft handover.

**Overview**

- In CDMA networks, it is possible to support soft handover in which connectivity is maintained during the handover.
- In a soft handover, interruption due to handover is avoided, since the mobile station may communicate with both the old and the new base station during the handover.
TCP/IP over WIRELESS NETWORKS

WIRELESS NETWORKS

Overview:

• GSM is a TDMA based digital cellular network for circuit-switched voice and data transmission.
• A mobile station accesses the Internet via a base transceiver and an access station controller.
• An IWF in an MSC serves as the interface between GSM and the fixed telephone network which in turn is connected to the Internet.

GSM

• In GSM, a mobile-assisted handover scheme is applied.
• The mobile station performs measurements of the radio quality and reports this information back to the network which in turn uses the information to decide if a handover should be initiated.
• A handover takes about one second to complete.
• A mobile station communicates with one base station at a time which implies that a short interruption occurs due to handover.

• General Packet Radio Service (GPRS) is a packet-oriented extension to GSM which provides for higher data rates and more efficient network utilization compared to circuit-switched GSM.
• GSM channels, each corresponding to a time slot, may either be reserved for GPRS or dynamically allocated when required. If no channels are exclusively reserved, a GPRS transfer may be interrupted due to preemption by traffic with higher priority, such as circuit-switched GSM.
• The data rate depends on the coding scheme.
• A mobile station may receive data on up to eight GSM channels, but most terminals today are not capable of receiving data on more than four channels.
• The maximum data rate for the most commonly used coding scheme is 11.4 kbps per channel.

• By combining wireless and satellite cellular technologies, UMTS makes it possible for you to enjoy all of the functionality of your home computer while you are roaming.
• This speed makes possible the kind of streaming video that can support movie downloads and video conferencing.
• One of the main benefits of UMTS is its speed. Current rates of transfer for broadband information are 2 Mbits a second.
• The radio resource management, for example, is placed closer to the mobile station, in the radio access network (UTRAN), instead of in the core network to the radio access network, the UMTS terrestrial radio access network (UTRAN).
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In comparison to fixed networks, wireless networks may seem to all have very similar properties. However, as presented above, a closer investigation shows that there are some important differences between various systems. Next, the presented wireless networks are summarized and contrasted with an emphasis on characteristics that may affect upper protocol layers.

When the radio quality is low, data loss may occur over a wireless link due to transmission errors. Handover typically results in delay and, in many cases, also in data loss. Delay is introduced, since it takes time to forward data to the new base station and to perform the handover procedure, e.g. signaling messages must be transmitted between the nodes involved in the handover.

Wireless networks have a long delay compared to wired networks, since transmission over a radio interface is slower than over a wired medium. Additional delay may be introduced due to processing on the physical layer and on the data link layer. Processing on the physical layer results in a constant delay. In cellular networks, processing on the physical layer (error correction and interleaving) is extensive and therefore gives a relatively long delay.

End of Chapter